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【プルーフの要否】　要

【書類名】　外国語明細書

1 Title of Invention

A Method for Bi-Predictive Weighting using Single Constrained Weight

2 Claims

1) A method for bi-predictive weighting using single constrained weight comprising the steps of:

obtaining the values of two motion compensated prediction blocks;

determining the temporal distances of the reference pictures and the current picture;

calculating the constrained weight and the shift denominator based on said temporal distances; and

calculating the values of the combined prediction block based on said weight and said shift denominator.

2) The method for bi-predictive weighting using single constrained weight according to claim 1,

where said prediction blocks are the results of motion compensation using each set of motion vectors.

3) The method for bi-predictive weighting using single constrained weight according to claim 1,

where said temporal distance represents the position of a picture in time relative to a particular picture.

4) The method for bi-predictive weighting using single constrained weight according to claims 1 and 2,

where said reference picture for motion compensation can be selected from a list of reference pictures stored in the buffer.

5) The method for bi-predictive weighting using single constrained weight according to claims 1, 2 and 3,

where said motion compensated prediction blocks can be predicted from the same reference picture.

6) The method for bi-predictive weighting using single constrained weight according to claims 1, where calculation of said constrained weight and said shift denominator comprising the steps of:

calculating the weighting factor;

calculating the shifting factor;

calculating said shift denominator by subtracting seven with said shifting factor; and

calculating said constrained weight by shifting said weighting factor to the right by the shifting factor.

7) The method for bi-predictive weighting using single constrained weight according to claims 1 and 6, whereby the calculation of said weighting factor comprising the steps of:

calculating the difference in said temporal distances between the current picture and the first reference picture;

shifting said difference to the right by seven;

calculating the difference in temporal distances between said first reference picture and the second reference picture; and

obtaining a weighting factor by dividing said shifted value with second said difference in temporal distance.

8) The method for bi-predictive weighting using single constrained weight according to claims 1, 6 and 7, whereby the calculation of said shifting factor comprising the steps of:

finding the absolute value of said weighting factor;

shifting said absolute value to the right by seven; and

calculating said shifting factor by counting the bit position of the most significant bit from the right for the said shifted absolute value.

9) The method for bi-predictive weighting using single constrained weight according to claims 1, 6, 7 and 8,

where said most significant bit is the first bit with the value 1 from the left.

10) The method for bi-predictive weighting using single constrained weight according to claims 1, 6, 7 and 9, where said shifting factor can also determined using the steps of:

adding one to said shifted absolute value;

finding the base-2 logarithm of the new shifted value; and

finding the nearest integer greater than or equal to the said base-2 logarithm value.

11) The method for bi-predictive weighting using single constrained weight according to claims 1, 5 and 6,

where the first default values are used for said constrained weight and said shifting denominator if said two prediction blocks are motion compensated from the same reference picture.

12) The method for bi-predictive weighting using single constrained w

eight according to claims 1, 5, 6 and 11,

where said first default values are used for said constrained weight and said shifting denominator if the reference picture for the second prediction block is not the first reference picture of the second list.

13) The method for bi-predictive weighting using single constrained weight according to claims 1, 5, 6, 11 and 12,

where each prediction block of motion compensation has its own list of reference picture indexes.

14) The method for bi-predictive weighting using single constrained weight according to claims 1, 5, 6, 11 and 12,

where said first defaults values for said constrained weight and said shifting denominator are one and one, respectively.

15) The method for bi-predictive weighting using single constrained weight according to claims 1, 5 and 6,

where said second default values are used for said constrained weight and said shifting denominator if said shifting factor is greater than seven.

16) The method for bi-predictive weighting using single constrained weight according to claims 1, 5, 6 and 15,

where said second default values for said constrained weight and said shifting denominator are one and zero, respectively.

17) The method for bi-predictive weighting using single constrained weight according to claim 1, where calculating the values of the combined

prediction block comprising the steps of:

subtracting the values of the second prediction block with the values of the first prediction block;

multiplying said subtracted values with said constrained weight;

adding said multiplied values with a shifting offset;

shifting said results to the left by said shifting denominator;

adding said shifted results with the values of said first prediction block to obtain said values of the combined prediction block; and

constraining said values of the combined prediction block to eight bits.

18) The method for bi-predictive weighting using single constrained weight according to claims 1 and 17,

where said shifting offset is one shifted to the left by the said shifting denominator minus one.

19) The method for bi-predictive weighting using single constrained weight according to claims 1, 17 and 18,

where said shifting offset is zero if the shifting denominator equal to zero.

20) The method for bi-predictive weighting using single constrained weight according to claims 1 and 17, where constraining said values comprising the steps of:

setting said values of the combined prediction block to two hundred and fifty five if said values are greater than two hundred and fifty five; and

setting said values of the combined prediction block to zero if said values less than zero.

3 Detailed Description of Invention

3.1 Industrial Field of Utilization

This invention can be used in any advanced multimedia data coding, especially in ISO/IEC 14496-2 Part 10 standard, to improve the quality of bi-predictive coded pictures. This invention helps to improve the coding efficiency of video sequences with fading effects. These fading effects are very common to be found in movie and music videos clips.

3.2 Background and Prior Art

Bi-predictive motion compensation in video compression technique is usually used to improve the compression ratio of the video. Two blocks of predictive samples are obtained using motion vectors and motion compensations on the previously decoded reference pictures. In conventional video coding techniques, these two motion compensated prediction blocks are averaged to obtain the final block of prediction samples.

Some video compression techniques, for example like ISO/IEC 14496-2 Part 10 standard, allows certain weights to be applied to the two motion compensated blocks. The combined prediction block may have a stronger weight for one of the prediction block and a weaker weight on the other. Figure 1 shows an example of how the Bi-predictive weighting is performed. For convectional Bi-predictive coding, a and b values are and , respectively. However for sequences with fading effects, a different values of a and b would result in a better compression.

Figure 2 shows the prior art in determining the bi-predictive weights based on the temporal distance for the interpolation case. As shown in Figure 2, the weights W0 and W1 are derived from the equations (1) and (2).

$$W0 = (128*(T1-T)) / (T1-T0) \qquad (1)$$

$$W1 = (128*(T1-T)) / (T1-T0) \qquad (2)$$

Where T, T0 and T1 represent the temporal representations of the current picture, the reference picture for prediction block 1 and the reference picture for prediction block 2, respectively.

The values of combined prediction block can be derived from the weights based on the equation (3).

$$P = (P0*W0+P1*W1+64) >>7 \qquad (3)$$

Where P0 and P1 represent the pixel values of the prediction blocks 1 and 2, respectively. Similar to the Figure 2, the weights for the extrapolation case in figure 3 can be calculated based on equation (1) and (2). However in the extrapolation case, one of the weights will be greater than 128.

The prior art requires division operations to determine the weights. To speed up the computation process of the combined prediction block, the weights are usually pre-calculated at the start of every picture to save computation time. These weights are stored in a table and retrieved at the block level based on reference picture indexes. For video compression techniques like ISO/IEC 14496-2 Part 10 standard that support multiple reference pictures for prediction, the size of this two-dimensional look-up table depends on number of reference pictures that can be used for picture. The number of entries in this table is the square of the number of reference pictures available for prediction as shown in equation (4).

$$N = Nref \times Nref \qquad (4)$$

Where N is the number of entries in the look-up table and Nref is the number of reference pictures available for prediction. Each entry in the table will contain W0 and W1 values.

Video compression techniques like ISO/IEC 14496-2 Part 10 standard also allows the two prediction blocks P0 and P1 to be from the same reference picture. Thus in this case, the temporal distance T1 T0 will be zero. To prevent the division by zero, both weights, W0 and W1, will be defined as 128 and 128, respectively.

Figure 4 shows the block diagram illustrating the prior art in calculating the prediction block P. Firstly, the values of P0, P1, T, T1 and T0 are obtained in module 401. The values of T1 and T0 will then be compared to see if they are the same in module 402. If the two values are the same, both the values of W0 and W1 will be set to 128 as shown in module 404. On the other hand, if these two values are different, W0 and W1 will be calculated based on equations (1) and (2), respectively as shown in module 404. The values of the combined prediction block P will then be calculated based on the values W0, W1, P0 and P1 using equation (3) as shown in module 405.

3.3　Problem to be Solved

The prior art for Bi-Predictive weighting requires pre-calculating the weights in order to avoid the division operation when obtaining the prediction samples. The number of weights to calculate will depends on the number of reference pictures available. So for the worst case, the number of weights that are required to calculate is one thousand and eight hundred if there are thirty different reference pictures available. This would mean one thousand and eight hundred division operations per picture for the worst case.

Beside this, the intermediate operations required to obtain the prediction values of the Bi-Predictive weighting will exceed 16 bits. This is because in the extrapolation case, one of the weights will be greater than 128 and the multiplication in equation (3) will result in a signed value greater than 16 bits. Thus these operations need to be performed in 32-bits boundary in order for the values not to overflow. This would mean a longer processing time to perform the Bi-Predictive Weighting for processors capable of performing parallel operations in 16 bits

3.4 Means of Solving the Problem

To solve the problem, a new method of Bi-Predictive Weighting using single constrained weight is introduced. The new method can be implemented using 16 bits operations and the number of weights to pre-calculate is much lesser than the prior art.

Currently, the algorithm to perform the Bi-Predictive Weighting in the prior art is not efficient to be implemented in parallel operations and it requires two weights to be pre-calculated for every combination of the reference picture of the first direction and the reference picture of the second direction. What is novel about this invention is that this invention only requires one weight to be calculated for each combination of the reference pictures and number of weights to be calculated is constrained to the number of reference pictures. Thus the number of division operations is greatly reduced.

3.5 Operation of the Invention

The operation of the invention is described hereafter. This invention can be applied after obtaining two blocks of prediction samples using bi-predictive motion compensation. This invention is applied to merge the two blocks of prediction samples to form single block of predicti

on samples to be used for reconstructing the pixel values of the picture.

3.6 Embodiments

The current invention can be used to perform bi-predictive weighting with lesser complexity as compared to prior art. Instead using two weights, the current invention uses only one weight to perform the bi-predictive weighting. Equation (5) shows the new equation for determining the values of the combined prediction block based on W1, P0 and P1.

$$P = P0 + ((P1-P0)*BWD) \gg LWD \quad (5)$$

As shown in equation (5), only BWD and LWD need to be calculated. The weight BWD is determined based on equations (6), (7) and (8).

$$BWD0 = ((T-T0) \ll 7)/(T1-T0) \quad (6)$$

$$LWD0 = \mathrm{Ceil}(\log2(1+(\mathrm{abs}(BWD0) \gg 7))) \quad (7)$$

Where the function Ceil(x) rounds x up to the nearest integer greater than or equal to x. The function log2(x) returns the base-2 logarithm of x and the function abs(x) returns the absolute value of x.

$$BWD = BWD0 \gg LWD0 \quad (8)$$

The shift parameter LWD in equation (5) is calculated using equations (6), (7) and (9).

$$LWD = 7- LWD0 \quad (9)$$

LWD0 in equation (7) also means the number of bits to represent the integer value of abs(BWD0)>>7.

The current invention can be implemented using 16 bits with the help of equation (8). Equation (8) will constrain the weight such that the intermediate multiply operation in equation (5) will not exceed 16 bits. Thus the bi-predictive weighting can be easily implemented in parallel operations using 16 bits operations. To reduce the computations, the values of BWD and LWD can be pre-calculated and stored in a look-up table at the start of the picture or slice.

Besides this, a new constraint is applied in the current invention to reduce the number of calculations needed to pre-calculate the weights at picture or slice basis. The constraint is that if the reference picture for the prediction block P1 or the temporal representation of prediction block P1, T1, does not belong to the first reference picture of the second list (list 1), a default weight will be used. For ISO/IEC 14496-2 Part 10 standard, the first reference picture of the second list is the reference picture with index 0 of list 1. The default weight will be BWD equal to 1 and LWD equal to 1. Similarly if the LWD0 is calculated to be greater than 7, another default weight will be selected. This weight shall be BWD equal 1 and LWD equal to 0.

Figure 5 shows the current invention in determining the values of the prediction block using bi-predictive weighting. The values of P0, P1, T, T0 and T1 are obtained in module 501. Firstly, the first check is applied to see if the reference picture for the prediction block P1 is the first reference picture in the list (i.e. index 0 of list 1) as shown in module 502. If the condition is false, in another words the reference picture used for prediction for P1 is not the first reference picture in the list, the first default weight will be used as shown in module 504. The first default weight has the values of BWD equal to 1 and LWD

equal to 1. If the condition in module 502 is true, a second check is applied to see if the values of T1 and T0 are the same as shown in module 503. If the values are the same, the first default value will be applied in module 504. On the other hand, if the values of T1 and T0 are not the same, the values of BWD0 and LWD0 will be calculated in module 505 using equations (6) and (7), respectively.

In module 506, the value of LWD0 is then checked to see if it is greater than seven. If it is greater than seven, the second default weight will be applied in module 507. The second default weight has the values of BWD equal to 1 and LWD equal to 0. If the value of LWD0 is less than seven, the values of BWD and LWD will be calculated in module 508 based on the equations (8) and (9), respectively. Lastly, the values of the combined prediction block P are calculated based on the determined values of BWD and LWD using equation (5) in module 509.

With the constraint introduced by the current invention, the number of calculations and the size required to construct the look-up table of weights is much smaller as compared to prior art. The number of divisions required is equal to the number of reference pictures available minus one. The reason is because the rest of the entries in the look-up table are using the default weights. Thus only a small portion of the weights is required to be calculated.

3.7 Effects of Invention

The effect of the present invention is to effectively perform the bi-predictive weighting of two motion-compensated blocks. The effect is evident in the form of lesser computations in obtaining the values of the bi-predictive weighted block at both the encoder and decoder.

4 Brief Description of Drawings

Figure 1 Shows the concept of bi-predictive weighting of two prediction blocks.

Figure 2 Shows an example of the prior art in determining the bi-predictive weights for the interpolation case using temporal distance.

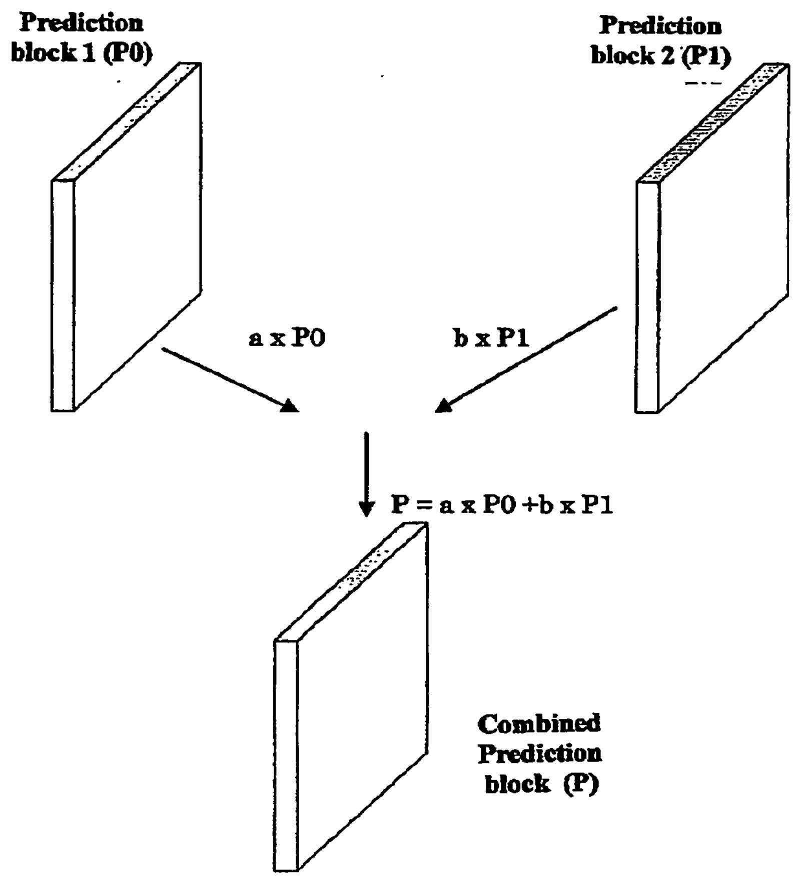
Figure 3 Shows an example of the prior art in determining the bi-predictive weights for the extrapolation case using temporal distance.

Figure 4 Shows the prior art in the process to calculate the values of the prediction block using bi-predictive weighting.

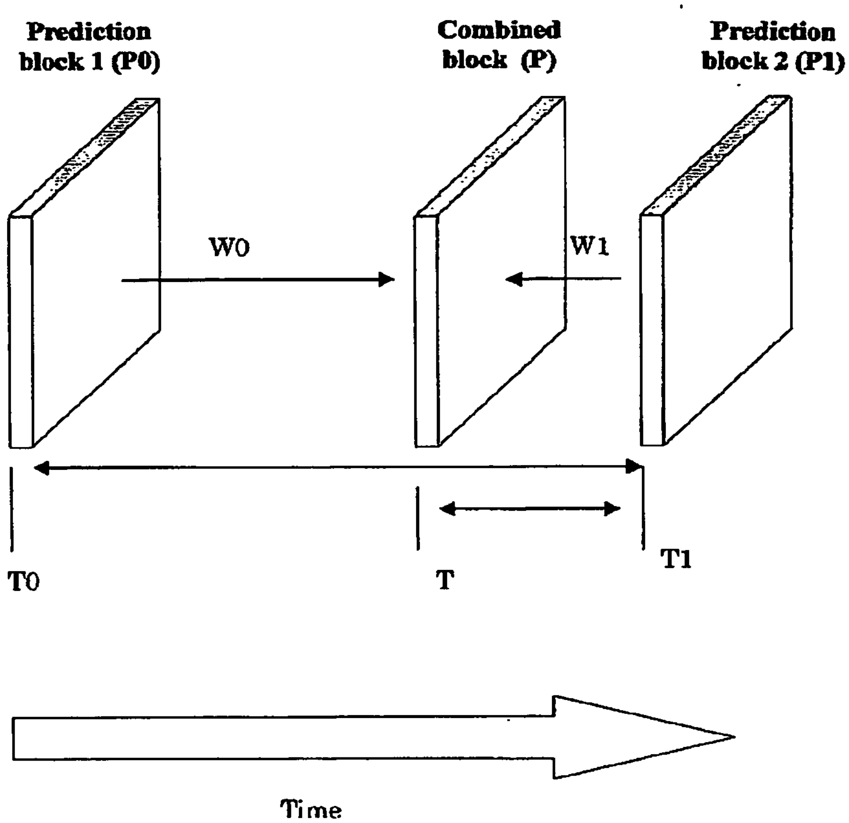
Figure 5 Shows the current invention in the process to calculate the values of the prediction block using bi-predictive weighting.

【書類名】　外国語図面

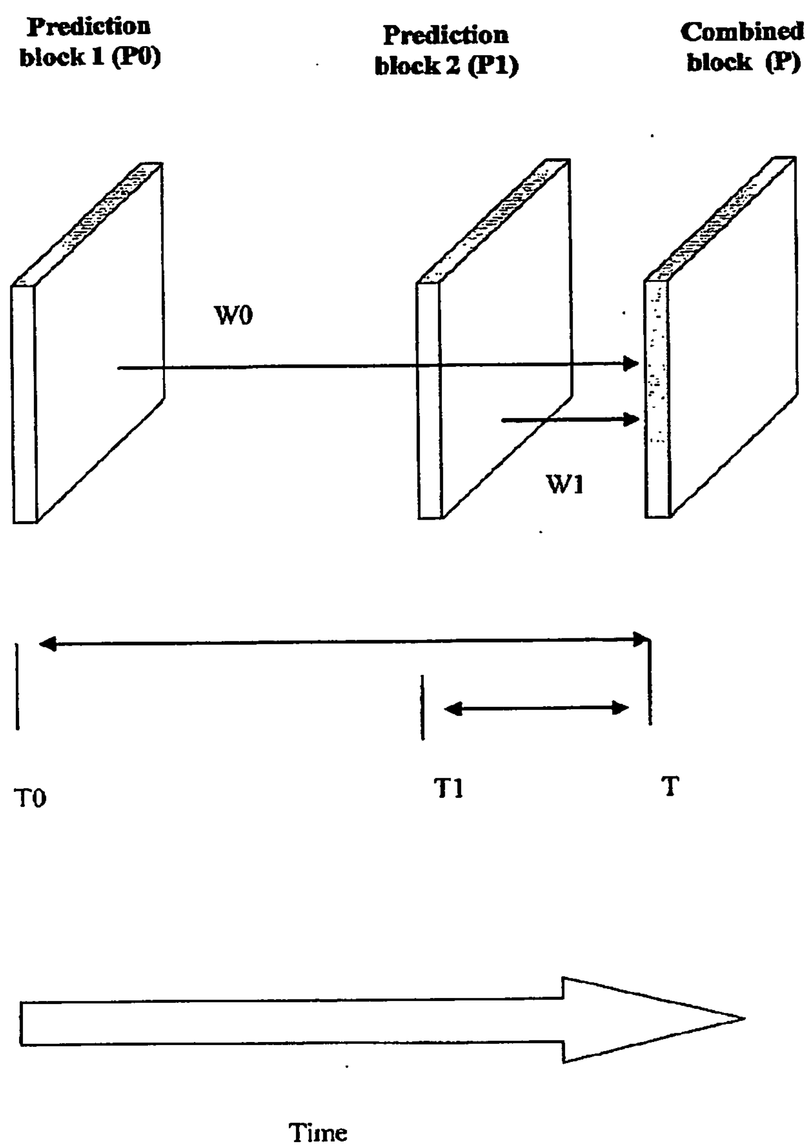
【図１】


Prediction
block 1 (P0)
Prediction
block 2 (P1)
a x P0
b x P1
P = a x P0 +b x P1
Combined
Prediction
block (P)

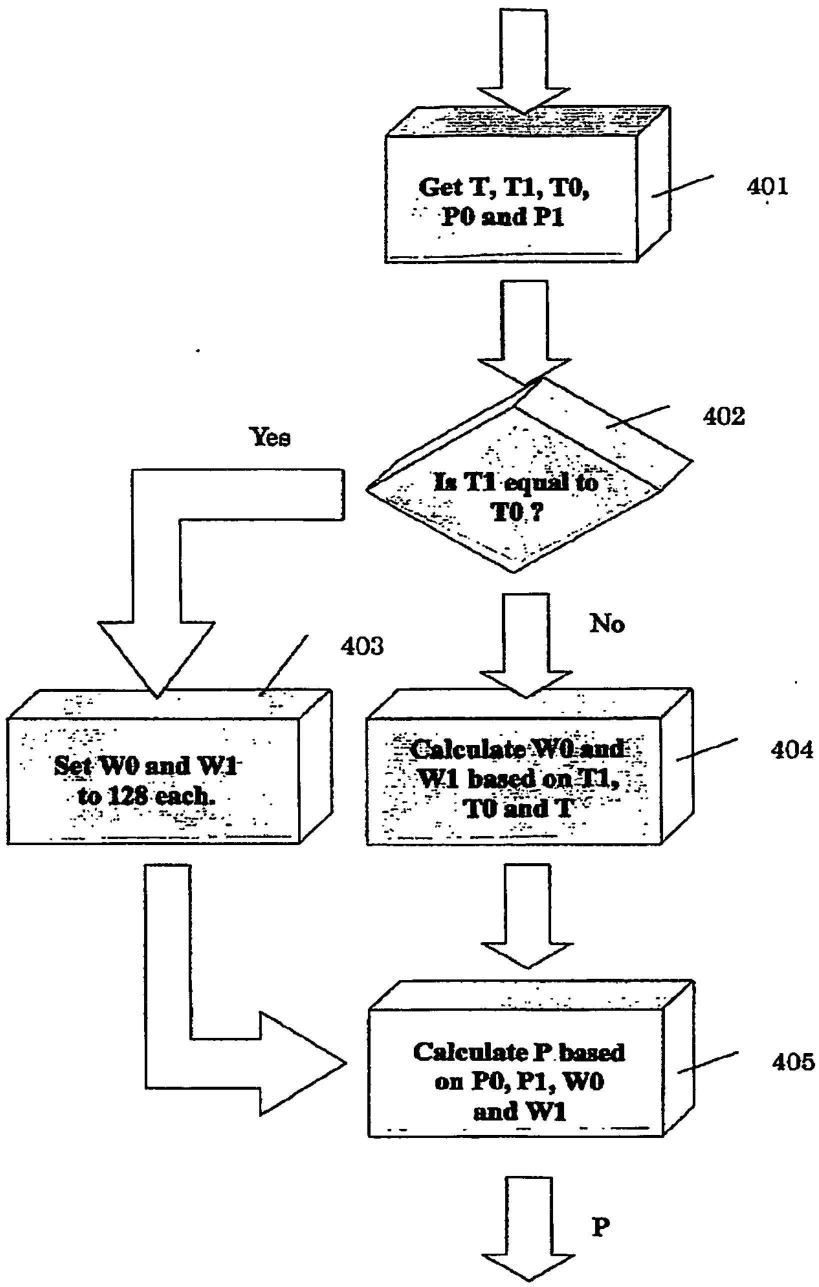
【図2】


Prediction
block 1 (P0)
Combined
block (P)
Prediction
block 2 (P1)
W0
W1
T0
T
T1
Time

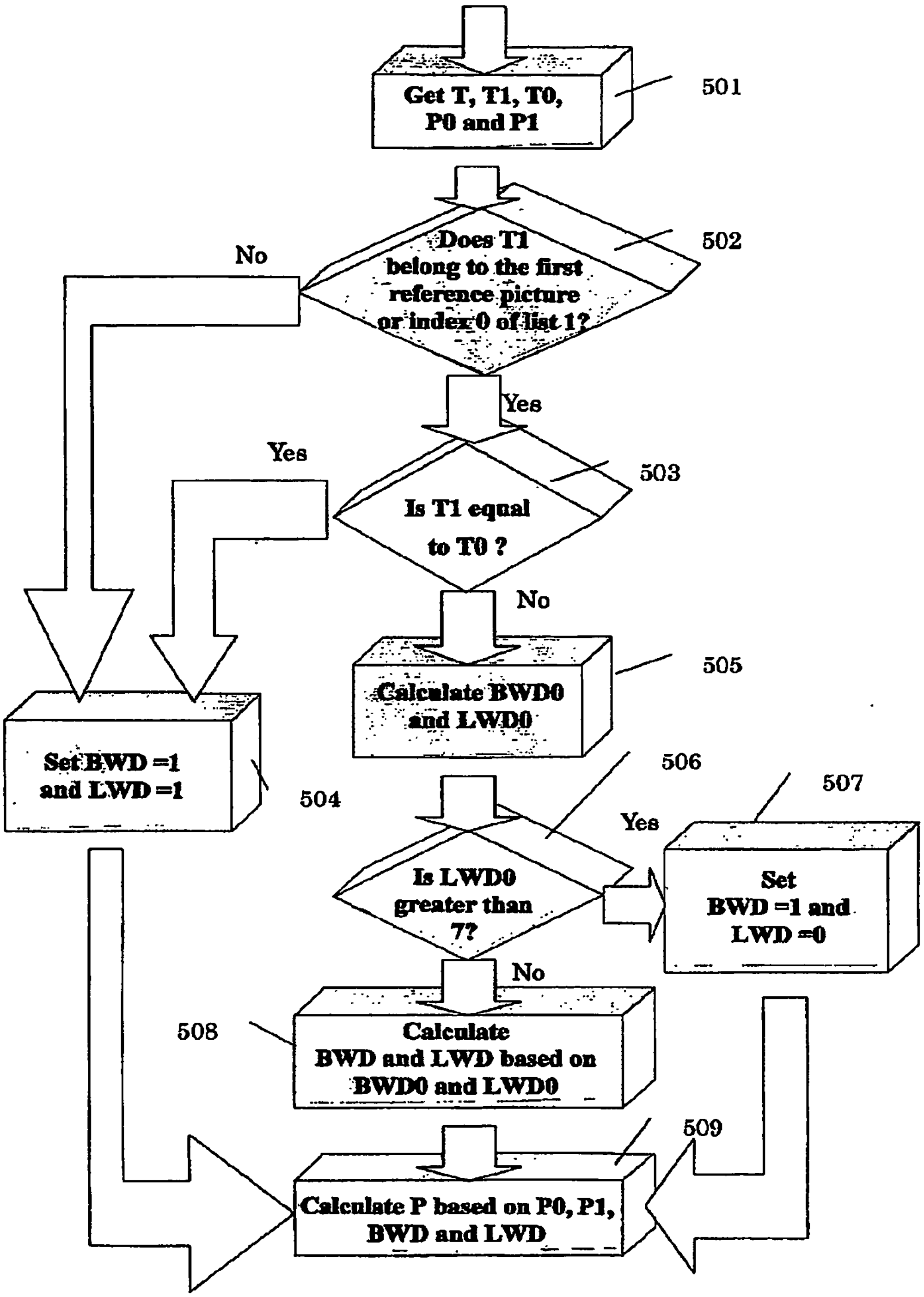
【図３】


Prediction
block 1 (P0)
Prediction
block 2 (P1)
Combined
block (P)
W0
W1
T0
T1
T
Time

【図4】


Get T, T1, T0,
P0 and P1
401
402
Yes
Is T1 equal to
T0 ?
No
403
Set W0 and W1
to 128 each.
Calculate W0 and
W1 based on T1,
T0 and T
404
Calculate P based
on P0, P1, W0
and W1
405
P

【図５】



Get T, T1, T0, P0 and P1
501
Does T1 belong to the first reference picture or index 0 of list 1?
502
No
Yes
Is T1 equal to T0 ?
503
Yes
No
Calculate BWD0 and LWD0
505
Set BWD =1 and LWD =1
504
Is LWD0 greater than 7?
506
Yes
Set BWD =1 and LWD =0
507
No
Calculate BWD and LWD based on BWD0 and LWD0
508
Calculate P based on P0, P1, BWD and LWD
509

【書類名】　外国語要約書

1 Abstract

The video compression technique described in the final committee draft of ISO/IEC 14496-2 Part 10 standard allows weighting to be performed on bi-predictive blocks to improve coding efficiency of fading sequences. An algorithm is used in the current final committee draft of ISO/IEC 14492-2 Part 10 to calculate the weights needed for bi-predictive weighting and to calculate the values of combined prediction block based on the weights and the two motion-compensated blocks. However this algorithm is not efficient in the sense that it cannot be implemented using 16 bits operations and the number of computations required to determine the weights in quite large for the worst case. For example, if the number of reference pictures is thirty, the number of weights that needs to be calculated is one thousand and eight hundred. The current invention in this document handles this by introducing a constraint on the number of weights that needs to be calculated and thus most of the weights will be using default weights. A new algorithm is also introduced in this document to perform a constrained bi-predictive weighting using a single weight in the calculation and thus the intermediate operations of this new algorithm will not exceed 16 bits. The effect of the current invention is a reduction in complexity in performing bi-predictive weighting.

2 Representative Drawing

Figure 5

認定・付加情報

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出　願　人　履　歴　情　報

識別番号　　　　　　　　［０００００５８２１］

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